Finding the Break

The patent-pending INEEL DataTrace technology can detect pipeline damage and transmit that data to a central receiving station.

DataTrace

Pipeline Damage Detection and Location

DataTrace is a new technology that uses the electrical properties of sprayed coatings on pipelines for the detection and location of damage and the transmission of that data to a central receiving station.

The Technology

Thermal-spray technology can be used to create insulating layers and electrically resistive traces on relatively flat surfaces. When applied to the interior or exterior of the pipe wall, the resistive traces act like strain gauges and change resistance when the wall is deformed. Because the sprayed trace is physically different than solid wire used in typical strain gauges, the traces behave uniquely when placed under strain.

- Resistivity of solid conductors remains constant under strain.
- Resistivity of thermal-sprayed conductors increases under strain due to the voids between the metal splats. The path of the current becomes more torturous.

A system of parallel traces can be used to detect, quantify, and physically locate the position where a deformation occurs. The chosen technique is a trace network whose topology or physical organization uses the change in resistance of the traces to both locate and measure plastic deformation. Simple, direct measurements are all that is needed to

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identify in real time that damage has occurred.

Application to the Pipe Wall

Both insulating alumina and conductive metallic traces are applied to either the interior or exterior of the wall pipe with a plasma spray system. The spray head is inches in dimension and is applied with electrical power, powdered feedstock, and inert gas. The head assembly, which can be deployed remotely, has been used previously for other commercial production and field applications of sprayed coatings.

Damage Detection

Thermally sprayed conductive traces exhibit changes in resistance when strain occurs. Laboratory experiments indicate that resistance changes resulting from point-source incidents such as being struck by a backhoe or distributed strain such as that resulting from a landslide should be readily measurable. Initial tests were conducted in the laboratory on a 2" by 12" flat plate with a single trace. The concept was subsequently verified on large test sections, 9' by 3" and 9' by 8" schedule-40 pipe.

Tests conducted with the flat plate correlated deformation of the plate with resistivity of the trace. These data are shown in Figure 1. These tests confirmed the relationship between strain and resistivity in the trace. Subsequent testing was conducted on the 9 ft pipe section, which was physically deformed using a backhoe. Measurement of the resistivity on both sides of the break showed a 20 to 30 percent increase in resistivity compared to measurements before denting the pipe in the immediate area of the damage. These results are shown in Figure 2.

Nine-foot pipe section damaged by a front-end loader for testing (below). 9 ft. Pipe Trace Resistivity vs. Impact Location (right top). Strain vs. Resistivity Plate Trace (right bottom).

Communication

Another objective of the thermal-spray channel research is to demonstrate that conformal thermal resistive coatings can be used to transfer information along a pipeline. Tests have demonstrated that this is possible. Extrapolating this result indicates that these traces can be used to communicate information at a bandwidth of 10kHz up to a distance of 27 km.

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Figure 1

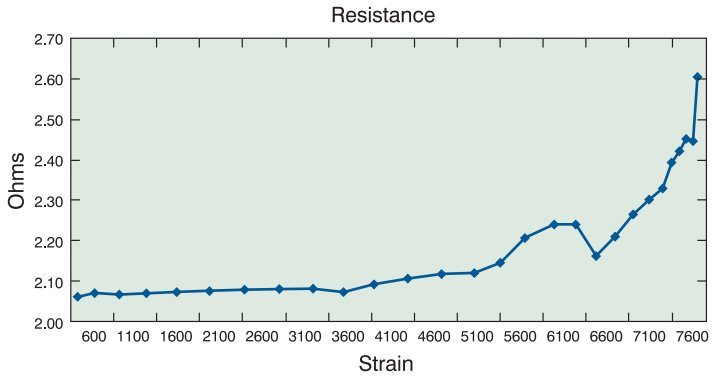

Figure 2